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XXV.—*On some curious Fossil Fungi from the Black Shale of the Northumberland Coal-field.* By ALBANY HANCOCK, F.L.S., and THOMAS ATTHEY*.

[Plates IX. & X.]

IT is now about ten years ago that a few sections of certain lenticular bodies were made and their peculiar tubular ramifications revealed. These bodies were then supposed to be of vegetable origin, and were procured in the Cramlington Black Shale. At the time we took these tubular ramifications to be those of a parasitic fungus related to the unicellular fungi described by Kölliker†; and as such our specimens were exhibited at one of the early microscopic soirées held by the Tyneside Naturalists' Field Club.

Since we first became acquainted with these curious and interesting bodies, we have collected a vast number of specimens (not less than 150) at Cramlington, Newsham, and other localities; and, having been engaged for the last few months investigating the subject, we now propose to give a succinct account of the results at which we have arrived, reserving for some future occasion more complete details of our researches.

First, then, with regard to the bodies themselves in which the peculiar structure alluded to is found. They are frequently circular, a good deal depressed and lenticular, with one side generally flatter than the other, sometimes quite flat. The largest are upwards of $\frac{4}{10}$ inch in diameter and nearly $\frac{2}{10}$ inch in thickness. Oval, depressed forms also occur, one of which in our possession is $\frac{8}{10}$ inch in length, though one extremity is wanting, and $\frac{7}{10}$ inch wide. But by far the greater number

* Communicated by the Authors, having been read at the Meeting of the British Association held at Exeter in 1869.

† See Ann. & Mag. Nat. Hist. ser. 3. vol. iv. p. 300, Oct. 1859.

are somewhat irregular in form, mostly partaking, however, of the circle or ellipsis: one such elongated specimen is an inch in length. Some have the margin a little sinuous; others are even pedunculate, or at least have a narrow produced process at one end; and it is not uncommon to find them very much flattened, squeezed out as it were, till the margins are quite sharp. The surface is invariably dull and much like the matrix in texture, though in one or two instances we have perceived indications of a reticulated structure. They leave the matrix with great facility, frequently dropping out of it on the shale being split open.

When sections of these bodies are viewed by transmitted light, they vary in colour from carmine to warm yellow, resembling much in this respect fossil wood from the same locality, though the latter is never so bright in tint. Like fossil wood, too, the sections have a tendency to warp when placed on the slide, and consequently the outer margin or rim is frequently cracked all round on putting on the cover.

That they are non-calcareous is proved by a very simple experiment. If we place a fossil tooth or bone from the Newsham Shale in dilute nitric acid, a violent effervescence immediately ensues, and the result is that in an hour or two the specimens are either entirely broken down or are so much reduced that they crumble to pieces on being touched with the finger; hence it is evident that such fossils from the abovementioned locality retain their calcareous matter not much, if at all, changed. Now when we treat one of the lenticular bodies in question with nitric acid of the same strength, no action whatever takes place, and after being immersed in it for several hours no perceptible effect is produced. Fossil wood from Newsham Shale is likewise unaffected when subjected to the same influence. We have thus a proof that these lenticular bodies are non-calcareous, and strong presumptive evidence as to the probability of their being of vegetable origin*.

Indeed that they are so does not admit of a doubt. If there were no other evidence of the fact, it is demonstrated by their organic structure. Originally, as already stated, we took this organic structure (the tubular ramifications) to be a parasitic fungus, and the substance in which it was imbedded to be wood. And assuredly the tubular ramifications resemble very closely those of the unicellular fungi before alluded to, many species of which we have in our possession. The size and general character of the tubes, the mode of ramification, and

* Some account of these lenticular bodies has recently been given, in 'Scientific Opinion,' by Mr. T. P. Barkas, who supposed them to be fish-otolites.

particularly their bulbous enlargements, all agree very well with what we observe in these peculiar bodies. But there is one important difference: while, in the unicellular fungi, the tubes never sink deep into the substance in which they are lodged, ramifying immediately below its surface, those of the lenticular bodies, though they are connected with the periphery, permeate the entire mass. Our recent investigations, however, compel us to the conclusion that the whole, including the substance in which the tubes ramify, is but one organism, and that it is a fungus of a peculiar nature, related apparently in structure, and to some extent in form, to *Sclerotium stipitatum*, a very curious and abnormal species from India, described by Messrs. Berkeley and Currey in the 'Transactions of the Linnean Society' (1862, vol. xxiii. pp. 91 & 93). The internal structure of this living species is so similar to that of some of the coal-fungi in question, that, were it fossilized, it would assuredly be considered one of them. "The mass consists," says the Rev. M. J. Berkeley, "of very irregular, swollen, and sometimes constricted, more or less anastomosing and more or less densely compacted threads." These words might be used to describe the tubes of *Archagaricon conglomeratum*, one of our fossil fungi described in the sequel.

We have in our possession a section of *Sclerotium stipitatum*, and, after carefully examining it, we can find no important difference distinguishing it from sections of our coal-fungi. The irregular character of the tubes, their nodular enlargements, and the large terminal vesicles are all features that are found in both the recent and fossil species. And, moreover, many of the larger "threads" or tubes in *Sclerotium stipitatum* can be seen abutting with their ends against the dark peripheral cuticle, just as the tubes do in the fossil species, the bark or cuticle of which is similar in definition and thickness, and is also dark and opaque*.

On examining sections of these lenticular fungi from the coal-shale, we find that they occasionally appear to be almost, if not entirely, homogeneous, and that, when perfect, they al-

* Since the above was written, we have obtained from Newsham a very interesting specimen of our new fungus, with the surface in excellent preservation. We have stated in the text that traces of surface-reticulation had been observed; in this new specimen the whole surface is covered with a minute angular reticulation, sharply defined by grooves, and resembling most closely the cuticular reticulation represented in the figures of *Sclerotium stipitatum* illustrating the paper of Messrs. Berkeley and Currey already referred to; so that in general form, in this peculiar surface-reticulation, in the thickness and character of the cuticle, and in internal structure our fossil fungi agree with this peculiar species from India.

ways exhibit a peripheral bark or cuticle of considerable thickness, though they vary in this respect, the cuticle being sometimes comparatively thin. The colour, as before mentioned, varies from a pretty clear carmine to a warm yellow, the intensity, of course, varying with the thickness of the section, and also, to some extent, the tint. But the apparent homogeneity is not by any means constant; indeed by far the greater number of specimens show the peculiar structure before mentioned, some to only a slight degree, others very extensively, the whole mass being filled with, nay, almost composed of, ramifying tubes. The tubes vary considerably in size in the different species (for there are many species of these fungi), and, in fact, to some extent in the same species. In some they measure $\frac{1}{600}$ inch in diameter; in others they are quite minute, being only $\frac{1}{1500}$ inch in diameter; in some they are plain; in others, again, they terminate in large bulb-like swellings, and have here and there similar but smaller enlargements, two or three of such being occasionally placed close together. The tubes always appear to originate in the peripheral cuticle.

The mode of ramification also varies: in some species the tubes are long, and may be said to branch rather freely; but in others they are cramped and much contorted; they are usually inextricably involved; and in a few instances they radiate from centres, and are short, sinuous, and stout. In all cases they terminate in rounded extremities when not in bulbs.

The branches are very frequently sharply defined, and exhibit a double marginal line, indicating that they have proper walls. They are occasionally filled with the matrix; and then they are black and perfectly opaque, and have a very striking appearance. The contained black matter is continuous with the external matrix, and from this fact it may be inferred that the tubes open externally; indeed their arrangement seems to indicate this; however, they are usually transparent, and reveal within their walls oval spore-like bodies, which pervade both the branches and the bulbous enlargements. Similar spore-like bodies are frequently scattered through the substance of the fungus amidst the ramifications; and in a few specimens in our possession these spore-like bodies are thickly scattered throughout the entire substance, no tubes or any other structure being perceptible. In others, again, nothing is observed in the homogeneous matter except circular vesicles resembling the bulbous enlargements of the tubes; in some instances such vesicles, large and small, are mingled together, and have scattered amidst them the spore-like bodies. In one

remarkable specimen the vesicles seem to be formed into a connected congeries towards the margin.

Another variety of these curious fungi has the outer bark or cuticle rather thick; and it seems to be composed of two or three layers. Immediately within the innermost layer there is a thin stratum of minute granules, which in some specimens is much extended, and the granules enlarged. In the former the quarter-inch object-glass is requisite to resolve them; in the latter an inch glass shows them very well. And, what is rather peculiar, at certain points of the circumference the bark or cuticle is folded inwards, the *outer* layer to a much less extent than the *inner*, thus leaving a wide space between the two. These inward foldings, of which there are three or four, bulge considerably into the substance of the fungus, and are somewhat reniform or ear-shaped. The stratum of granules follows the infoldings with the greatest regularity.

There is still another variety, which differs considerably from all the rest. This is without tubes, the whole substance being composed of large polygonal cells having the appearance of coarse cellular tissue, with here and there a dark, irregular, spherical body.

Such are the variations in the structure of these Coal-measure fungi: they are, we have said, occasionally structureless or nearly so; but this is rarely the case. We have sixteen specimens that appear either homogeneous or almost so, out of 126 sections, all the rest (110) exhibiting more or less structure. This fact militates strongly against the idea we at first entertained, that the tubular structure was a fungus parasitic in the bodies in which it is found. Were such the case, these figures ought to be reversed: 16 bodies so affected might be found in 126; but certainly we should never expect to find out of that number 110 affected and 16 only free from the parasite.

The apparent entire homogeneity of some specimens, and the apparent partial homogeneity of others, can be accounted for as the result of fossilization. Fossil wood and other vegetable substances have frequently the structure either wholly or partially obliterated by pressure. This is not uncommonly the case with wood found in the Newsham Coal-shale; and it can scarcely be doubted that such is the case with the fungi in question. We presume that the general substance of these bodies is composed of cellular tissue (and, indeed, in one of the varieties above mentioned we have seen that it is chiefly made up of cellular tissue, and traces of such a structure have been observed in one or two other instances), and that by pressure this is almost universally obliterated. The ramifying tubes,

with the spore-like bodies, being of a less delicate nature, or in some way less perishable, are sometimes preserved throughout the mass, at other times only partially preserved; occasionally the tubes are so strongly defined, that every characteristic is retained; again so delicate and attenuated are they, that their margins only can be perceived, dying out until the faintest traces of them subside into the surrounding homogeneous substance.

Those specimens that exhibit only cell-like bodies, large and small, may have had likewise ramifying tubes, and pressure may have obliterated them; or they may have had a continuous connected congeries of cells opening at the surface, as the tubes would seem to do; and in one instance, at least, extensive traces of such a structure exist. In this case the spores will have been developed in the cells; and, in fact, spore-like bodies have been observed in connexion with these cells.

We have already stated that the tubes originate in, and apparently open at, the periphery of the fungus, and that spore-like bodies are occasionally found within the tubes and the bulbous enlargements in connexion with them. Such being the case, it is only necessary to suppose (and, indeed, from what we have seen, apparently the fact is such) that the tubes are invaginated prolongations of the outer envelope or cuticle, in order to bring the organization of these coal species into some accordance with the structure of the higher fungi, in which the spores seem to be always developed in connexion with folds, tubes, or processes of one kind or other of the enveloping membrane or cuticle, or, more correctly speaking, of the hymenium, which is itself apparently a continuation of the peripheral investment.

We shall now conclude this very imperfect account of these interesting Coal-measure fungi with concise descriptions of a few of the more characteristic species, leaving the rest (probably as many more) for further investigation, which we hope will throw additional light on this intricate subject.

DESCRIPTIONS OF SPECIES.

1. *Archagaricon bulbosum.*

Tubes of equal size, about $\frac{1}{1000}$ inch in diameter; the main branches pretty straight, long, somewhat sinuous, with the secondary branches much contorted, involved, and crowded; occasionally papillose, and frequently terminating in large spherical vesicles, and with smaller bulbous enlargements, sometimes two or three in close succession, their diameter

being three or four times that of the branches, the terminal vesicles being much larger.

Several specimens of this species have occurred; and we have two or three of what we consider to be a variety of it, with similar branches; but neither have they bulbous enlargements nor are they papillose. The peculiarities of this variety are probably owing to its state of development.

2. *Archagaricon globuliferum.*

Tubes various in size, the larger about $\frac{1}{2000}$ inch in diameter, smooth; both stems and branches straight or very little sinuous, with numerous globular enlargements five or six times the diameter of the tubes, and with a few extremely large spherical vesicles, many times larger than the globular enlargements, some of them being $\frac{1}{80}$ inch in diameter.

This species is distinguished from *A. bulbosum* by the straightness, smoothness, and minuteness of the branches, and also by the more numerous globular enlargements, and particularly by the great size of the terminal vesicles. Several specimens have been obtained.

3. *Archagaricon radiatum.*

Tubes large, measuring $\frac{1}{600}$ inch in diameter, short, smooth, a little tortuous, and appearing as if radiating from centres, but not with much regularity; their margins are not always exactly parallel, but usually somewhat irregularly sinuous.

This is a very characteristic species, and cannot be confounded with any other. We have two specimens exactly agreeing in the above characters; a third has, in addition to the radiating tubes, large, irregular, rounded vesicles. The variation is probably owing to a different state of development. The fungus is elongated and rather small.

4. *Archagaricon dendriticum.*

Tubes very minute, $\frac{1}{15000}$ inch in diameter, arranged in dendritic tufts in connexion with the periphery of the organism, and having interspersed large elliptical vesicles, which are apparently terminal. When the branches are crowded, the tuft-like arrangement is obscured.

We have only two specimens of this pretty species; they are irregularly circular, and are quite minute, being only $\frac{1}{10}$ inch in diameter. They do not exactly agree in internal structure, one of them having the terminal elliptical vesicles much more numerous than the other, and the organism crowded throughout with a vast number of similar vesicles.

5. Archagaricon conglomeratum.

Tubes large, uneven, cramped, and warty, irregularly enlarged and occasionally much constricted, anastomosing, and studded with cells of various sizes, sometimes so numerous that the tubes are much obscured, the whole mass appearing filled with them.

Several specimens have occurred of this well-marked species. The tubes are occasionally constricted to $\frac{1}{300}$ inch in diameter, and are sometimes enlarged to considerably more than twice that size. They are of an irregular form.

EXPLANATION OF PLATES IX. & X.

PLATE IX.

Fig. 1. Lenticular form of *Archagaricon.*
Fig. 2. Oval form.
Fig. 3. Irregular elongated form.
Fig. 4. Pedunculate form.
Fig. 5. Irregular form, with minutely reticulated surface.
Fig. 6. A portion of the surface, enlarged, to show the reticulations.
Fig. 7. Transverse section of lenticular form.

PLATE X.

Fig. 1. General view of a few of the tubes, much enlarged, of *Archagaricon bulbosum*: *a*, peripheral envelope or cuticle of the fungus; *b*, one of the large terminal vesicles; *c*, tubular enlargement.
Fig. 2. A portion of a tube of the same species, more highly magnified, with a terminal vesicle, showing the double marginal line.
Fig. 3. An enlarged portion of a tube, with bulbous swelling and papillose walls.
Fig. 4. The same, showing spore-like bodies within: *a*, spore-like bodies.
Fig. 5. Terminal extremities of three tubes without enlargements, showing double marginal line.

XXVI.—*Descriptions of a new Genus and two new Species of* Scyllaridæ *and a new Species of* Æthra *from North America.* By SIDNEY I. SMITH*.

EVIBACUS, gen. nov.

Carapax very broad; lateral border expanded, incision at the cervical suture closed, and the margin behind it not incised. Rostrum broader than long, very slightly bilobed. Eyes situated midway between the rostrum and the outer angle; the orbits entire, slightly removed from the anterior margin and connected with it only by a suture. Antennæ with the inner margins approximate.

* From Silliman's American Journal, July 1869.